# Questions and answers around MRSA in pigs

**A rapidly increasing number of news items and studies have been spent on the emergence of Methicillin-resistant *Staphylococcus aureus* (MRSA) in pigs. Although not being a direct threat to pig herds, MRSA has become a topical issue for pig producers. *Pig Progress* endeavours to answer some of the most relevant questions.**

By David Burch, veterinarian, Octagon Services Ltd, Windsor, Berkshire, UK

At the recent International Pig Veterinary Society Congress in Durban, South Africa, there were several papers given on MRSA (Methicillin-resistant *Staphylococcus aureus*) in pigs. There is a European survey going on at the moment supported by the European Food Safety Authority (EFSA), following reports of high levels being found in Dutch and German pigs and also farm workers and vets, and now both Canada and the USA have also reported high levels found in pigs. What is the significance of this organism, which we normally associate with human medicine and epidemics in hospitals?

**Table 1. Mode of action and resistance to penicillins and cephalosporins by *S. aureus*.**

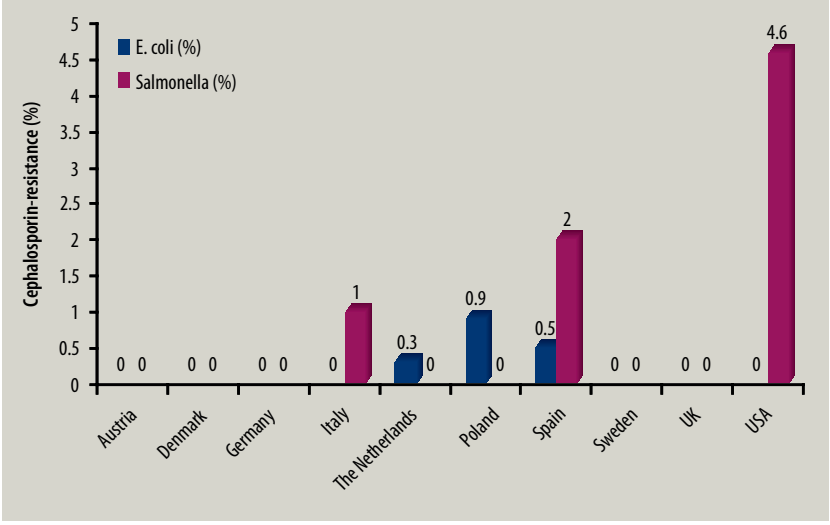
| Antibiotic type | Mode of action | Mode of resistance |
|---|---|---|
| Penicillin | Cell wall – binds to PBPs | Penicillinase production |
| Methicillin | Cell wall – binds to PBPs | Genetic changes to cell wall PBPs |
| | (Penicillinase resistant) | |
| Cephalosporins | Cell wall – binds to PBPs | Cephalosporinases and |
| | (Penicillinase resistant) | genetic changes to cell wall PBPs |

Nose-to-nose contact provides an excellent situation for MRSA to spread in a pig herd.

**Table 2. Various survey reports from Europe and North America.**

| Country | Pigs (%) | Farms (%) | Farmers (%) | Vets (%) | Other (%) |
|---|---|---|---|---|---|
| The Netherlands | 39 | 81 | 26 | 4.6 | 0.03 |
| | - | - | 50 regular; | - | general population |
| | | | 11 organic | | |
| Germany | 53 | 70 | - | - | - |
| | 13 | 18 | - | 36 | 14 meat inspectors; |
| | | | | | 38 field station personnel |
| Sweden | 0 | 0 | | - | - |
| Ireland | - | - | - | - | 2 associated personnel |
| Denmark | 2 | - | - | - | - |
| UK | No positive reports | - | - | - | 3 patients |
| Canada | 25 | 45 | 20 | - | - |
| USA | 70 | - | 45 | - | - |

**Figure 1. Cephalosporin resistance in *E. coli* and *Salmonella spp* in pigs from various countries.**




***What is MRSA?***

*Staphylococcus aureus* is a bacterium that lives primarily on the (human) skin and is frequently associated with infections there, such as spots, boils and impetigo.

It can colonise the nose, not really doing very much harm. However occasionally it can penetrate into the blood stream and cause a bacteraemia (high temperature, fever, etc) and can settle out in various sites such as joints, which leads to arthritis; the respiratory tract, or lungs, leading to pneumonia; the heart, causing endocarditis, etc. In hospitals, it is often associated with surgical wounds or implants, especially after complicated operations, such as hip replacements. Patients, who have compromised immune systems, or are very young or very old, might also be more easily infected or susceptible, hence the concern by doctors to keep the organism out of hospitals; in some countries such as The Netherlands and Denmark there is intensive screening of patients.

When these infections occurred, the patients were commonly treated with penicillin. After a while the bacterium developed resistance to penicillin by producing enzymes (penicillinases) which broke down the penicillin. This led to the development of more advanced penicillinase-resistant penicillins such as methicillin. Penicillins attach to penicillin-binding proteins (PBPs) in the cell wall of the bacteria and stop them multiplying. Cleverly, to survive, the *Staphylococcus* genetically altered its PBPs so that the penicillin and methicillin could not attach and were therefore resistant to even methicillin.

This is also a very important process as the bacterium is then resistant to all other penicillins and related compounds such as the cephalosporins, which, because of their good safety and efficacy profile, are very commonly used in human medicine (see *Table 1*). When these antibiotics cannot be used, alternatives need to be found. In human medicine there are only a few antibiotics, which can be used, such as vancomycin.

There is often co-resistance or multiple resistances to other antimicrobial families transferred by this genetic change and these are usually against other antimicrobials that have also been extensively used. In human medicine the MRSA are also mainly resistant to fluoroquinolones but sensitive to tetracyclines, whereas in pig medicine the MRSA ST398 is usually resistant to tetracyclines but sensitive to fluoroquinolones and trimethoprim/sulphonamides (Van der Wolf and others, 2008).

***What effects does MRSA have on pigs?***

MRSA probably have little to no effect on the pig as *S. aureus* is not commonly a primary pathogen, more of an opportunist.

In young piglets, which have skin damage from rough flooring or fighting or infected navels or gums after teeth clipping, the organism can penetrate into the blood stream and cause a variety of infections. In one survey of 4,000 submissions to a diagnostic laboratory in the Netherlands (Van der Wolf and others, 2008) only 97 isolates (2.4% of cases) of *S. aureus* were found affecting joints (48%), lungs

(12%), heart and pericardium (8%), spleen (8%) the rest, brain, abscesses, kidney and blood were below 5%. The spread throughout the body is typical of a bacteraemia or blood-stream spread. Only 16 of these (0.4% of submissions) involved MRSA, demonstrating the low clinical impact the infection has in the pig, when surveys have shown 39% of Dutch pigs and 81% of farms have the infection (Wulf and others, 2008)

***What effects does MRSA have in man?***

The main concern in the Netherlands and other countries are that farmers, stockmen, vets and meat processors have a higher carriage rate than the normal population and are positive carriers when screened to go into hospital. In one Dutch survey using nasal swabs they found 50% of conventional pig farmers were positive carriers of MRSA (Wulf and others, 2008) and only 0.03% in the general population and in a German survey, 36% of pig vets, 14% of meat inspectors and 38% of diagnostic centre workers, who also visited pig farms (Blaha and others, 2008) were carriers.

The sequence type found in pigs, veal calves and broiler chickens is primarily MRSA ST398. This is not related to human hospital epidemic strains but potentially it can cause disease in humans if, for example wounds become infected or it gets into the blood stream. Most of the time, it will colonise the nose and be asymptomatic in the carrier.

***What are the survey results to date?***

The main question is from where has this strain of MRSA come, and how far has it spread? A number of surveys have been carried out and reported, or are in the process of investigation (see *Table 2*).

So what has induced or selected for this particular resistance development? It is too broad a statement that it is antimicrobial use. It is necessary to look for changes that have taken place recently, since 2004 when the strain appeared to emerge. Methicillin or the other advanced penicillins are not used in pig medicine, thus it suggests that it might be due to another advanced antimicrobial, such as a cephalosporin.

If we look at cephalosporin resistance from indicator bacteria such as *Escherichia coli* or *Salmonella spp* (data from 2005 in the EU and 2003 in the US) there is a loose correlation between cephalosporin resistance in these countries and reported incidence of MRSA (see *Figure 1*). There may be a few more surprises when the final EU MRSA survey figures come out, but hopefully the spread of the infection is not as wide as originally feared.

***How has it developed so quickly?***

The rapid spread of the infection would appear to be faster than say antimicrobial use alone. It appears in the Netherlands to have developed in breeding pyramids (Broens and others, 2008) and this is probably why the level of infection has spread so quickly. The MRSA seemed to be able to survive well due to good nose-to-nose transmission and by being present in pig dust. The pyramid has magnified the problem and in many cases the multiplier herds and finishing herds have become affected. The results in North Germany bordering the Netherlands are also high, especially in comparison with wider surveys where the prevalence appears to be less.

***What should we do about MRSA in the future on a national or farm level?***

Until ones own national results are known, which will not be until next year when the EFSA reports, extreme caution should be applied. Either do not buy in breeder pigs from known affected countries or regions in Europe, or make sure they are from herds that are MRSA negative. This means this is another question you should ask the breeder before purchasing stock.

Interest in biosecurity at a national and farm level has to be increased, although the infection with MRSA is not a major pig disease it could have a major negative impact on the consumer if uncontrolled and becomes widespread. The chances of MRSA being transferred from meat to man, however, are considered very unlikely, as the bacteria are only found in very small numbers in pork and would be destroyed by cooking. **PP**